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Nitrogen monoxide detector

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Figure 1 Schematic of Fast NO Detection System

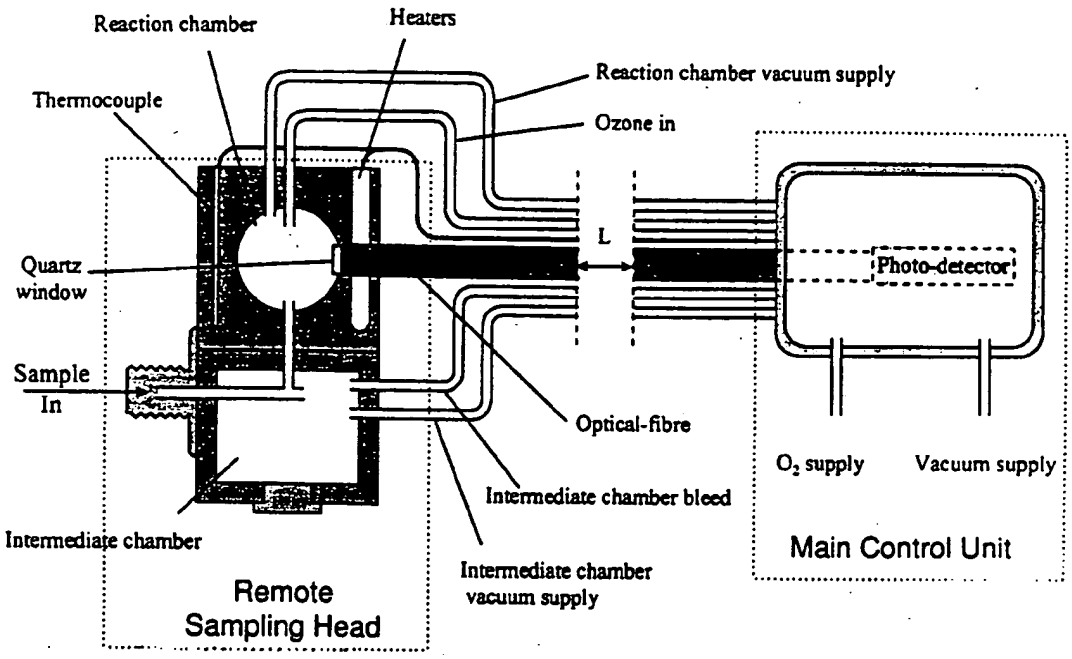
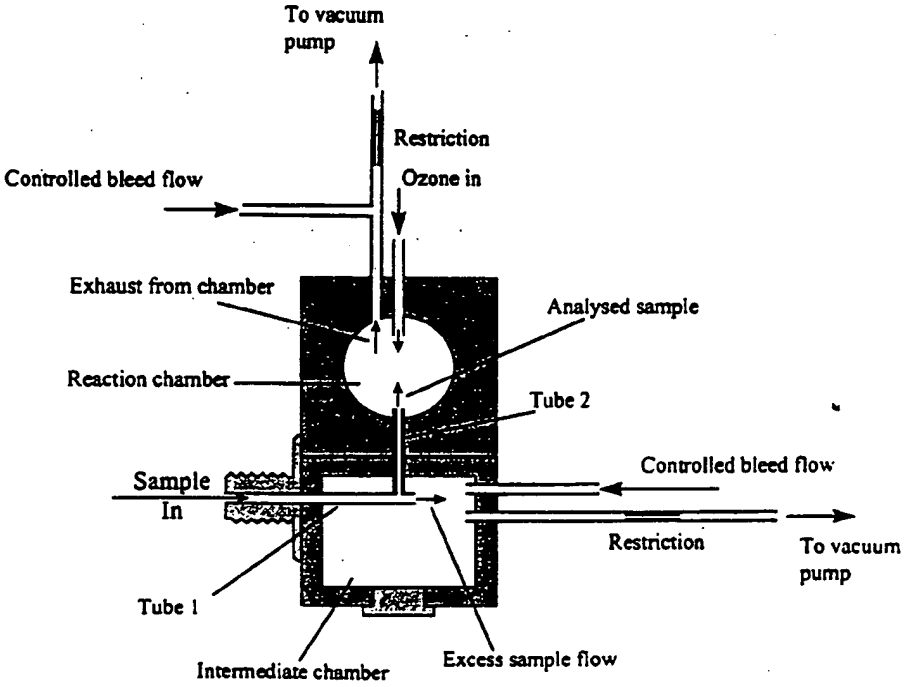


Figure 2 Schematic of gas sampling system



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Nitrogen monoxide detector

This invention relates to an instrument for measuring the concentration of nitrogen monoxide in a gaseous sample.

Measurement of the concentration of nitrogen monoxide is carried out for a wide range of applications. Instruments for measuring nitrogen monoxide concentration are widely known, however, the time response for accurate resolution of concentration fluctuations in such instruments is typically of the order of seconds.

In some applications it is desirable to measure nitrogen monoxide concentration fluctuations on a fast time-scale. One such application is in the analysis of the emissions from an internal combustion engine.

The present invention describes the configuration of an instrument for measuring the concentration of nitrogen monoxide with a time response of less than 4 milliseconds.

The present example will now be described by way of example, with reference to the accompanying drawings in which:

Figure 1 shows a complete schematic diagram of an implementation of the present invention.

Figure 2 shows a diagram of the sampling system of the present invention.

The technique used for nitrogen monoxide detection exploits the the chemi-luminescence phenomenon. This technique is widely used in detectors of nitrogen monoxide concentration. The technique exploits the fact that in the prescence of ozone, a proportion of nitrogen monoxide molecules undergo a reaction which produces light. This light may then be conducted to a photo-detector which produces an output proportional to the incident light level. If sufficiently concentrated ozone is used, then the light output and hence the photo-detector output may be made proportional to the nitrogen monoxide concentration.

It should be noted that the conditions for chemi-luminescence to occur involve temperatures of around 250°C and absolute pressures of around 30 mbar.

Figure 1 shows a schematic diagram of the instrument which consists of two main parts.

The Main Control Unit contains the electrical and fluid circuits which control the temperatures, pressures for the sampling system together with the circuits for the Photo-detector and amplifiers.

The Remote Sampling Head is located close to the sample gas origin and contains two chambers which are controlled to different pressures. The function of the Remote sampling head is to allow the reaction of a constant mass flow of sample gas independent of the pressure of the sample source.

The Reaction chamber of the Remote sampling head provides an enclosure in which a jet of sample gas is introduced to a jet of ozone. The resultant mixing process produces a reaction which leads to light emission which depends upon the nitrogen monoxide concentration in the sample. The light produced may be carried by an Optical fibre down an Umbilical cable/pipe bundle which joins the Remote Sampling Head to the Main control Unit. The length of this cable/pipe bundle (L in figure 1) may be around 10m. Alternatively, a Photo-detector may be mounted directly on the Remote sampling head.

Figure 2 shows the sample system flow schematic for the remote sampling head. The Intermediate chamber is controlled to a constant absolute pressure which is always below the sample source pressure. This arrangement results in a jet of sample gas being drawn into the Intermediate chamber through tube 1. The Reaction chamber is controlled to a constant absolute pressure which is always below the Intermediate chamber and hence a small fraction of the sample flow in tube 1 is drawn through tube 2 into the Reaction chamber. Tube 1 and tube 2 are arranged to be orthogonal and tube 2 forms a static tapping on tube 1. The pressure difference between the Intermediate chamber and the Reaction chamber is very close to the pressure drop across tube 2. The mass-flow of gas through tube 2 depends upon this pressure drop.

By careful regulation of the pressures in the Intermediate chamber and the Reaction chamber, the sample flow into the Reaction chamber may be made substantially independent of pressure fluctuations at the sample source.

In the Reaction chamber, the sample containing nitrogen monoxide is introduced to a flow of ozone.

The temperature of the Reaction chamber is controlled to a constant value by heaters and a Thermocouple mounted in the Remote sampling head.

Claims

1. A chemi-luminescence detector having improved response time to changes in nitrogen monoxide concentration in a source of sample gas, said chemi-luminescence detector comprising:
   - a housing, said housing enclosing a reaction chamber for the introduction of sample gas to a flow of ozone;
   - inlet means to said chamber for a controlled flow of ozone;
   - a tube arrangement for providing a jet of sample gas into said chamber;
   - a window and arrangement for the conduction of light emitted to a photo-detector;
   - an exhaust outlet through which the reacted gases are removed from said reaction chamber;
   - an intermediate chamber within said housing and couplable to a source of sample gas, disposed immediately adjacent to said reaction chamber and connected to said chamber by said tube arrangement which minimizes the length of the path the sample gas must travel in said chemi-luminescence detector thereby to improve its response time, said intermediate chamber being adapted to maintain a substantially constant static pressure, whereby the flow rate of said sample gas through said tube arrangement into said reaction chamber remains substantially constant, said intermediate chamber being maintained at a constant absolute pressure always less than that of said source of sample gas and said reaction chamber being maintained at a constant absolute pressure always less than said intermediate chamber, thus facilitating a flow of said sample gas from said sample gas source into said intermediate chamber and thence into said reaction chamber.
2. A chemi-luminescence detector according to claim 1, wherein said intermediate chamber has means couplable to means for applying a controllable pressure to said intermediate chamber for controlling the pressure in said intermediate chamber and for maintaining the substantially constant sample flow through said tube arrangement.
3. A chemi-luminescence detector according to claim 1, wherein said intermediate chamber is couplable to the sample gas source by means which result in a flow of sample gas into said chamber which is orthogonal to said tube arrangement connecting said intermediate chamber and said reaction chamber whereby a portion of the sample gas enters said tube arrangement substantially at the intermediate chamber static pressure.
4. A method according to claim 3, wherein said intermediate chamber is operated at sub-atmospheric pressure by applying a controllable vacuum to said means of applying a controllable pressure to said intermediate chamber.
5. A method according to claim 3, wherein said intermediate chamber is operated at super-atmospheric pressure.
6. A method according to claim 3, for measuring the nitrogen monoxide concentration in the exhaust gases of an internal combustion engine.